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THE PREVALENCE OF HOOKWORM AND OTHER INTESTINAL NEMATODES IN ADULT FILIPINOS

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INTRODUCTION

During the collegiate year 1921-1922 students of the University of the Philippines at Los Baños were examined for intestinal parasites in connection with medical examination that is required of all matriculants at the university. The object of the examinations for parasites was to determine primarily the incidence and degree of infestation of normal adult Filipinos with hookworms and, incidentally, to obtain information on the degree and extent of infestation of these individuals with other intestinal parasites.

Studies on intestinal parasitism in the native population of the Philippine Islands are not novel undertakings. Since the American occupation of the Philippine archipelago a number of surveys have been made with a view to determining the incidence of protozoan and helminthic parasites in Filipinos and the bearing of such parasitism on public health. These surveys have been based, for the most part, on studies of inmates of Bilibid Prison, of patients in the Philippine General Hospital, on records of the medical departments of the army and navy and on records of autopsies performed in the College of Medicine and Surgery of the University of the Philippines. Several investigations on the prevalence of intestinal parasites in certain localities have also been published, but despite the fact that a considerable mass of data have been accumulated, no parasitological study based on the normal heterogeneous adult population of the Philippines and carried out by modern methods has been published prior to this investigation.

The fact that the student population of Los Baños is typical of the population of the Philippine Islands in general was the chief reason why this study was undertaken. Forty-six provinces and subprovinces including the city of Manila are represented in this survey. The character of the student population at Los Baños is quite varied, embracing various economic classes in proportions approximating the relative proportions of these classes in the general insular population. The data obtained in the course of this investigation may be considered,

therefore, a fair index to intestinal parasitism in adult Filipinos, despite the fact that the number of cases studied has not been very great.

The results of our study relating to infestation with cestodes and trematodes have already been published (Schwartz and Tubangui, 1922). The object of this paper is to present the results of our survey as regards the prevalence of intestinal roundworms.

METHODS

Samples of feces were submitted by students ¹ who were furnished bottles containing about 50 c.c. of 10 per cent. formalin and were given directions to avoid contaminating the feces with soil and other objects. Each student was instructed to deposit his feces on clean paper and to place it, with the aid of a twig or clean stick, in the bottle containing formalin. This procedure proved altogether satisfactory because the preserving fluid eliminated possible dangers of infection as a result of

TABLE 1.—RESULTS OF EXAMINATIONS FOR INTESTINAL ROUNDWORMS

		Percentage
Number Examined	649	
Number infected	550	84.76
Number infected with hookworm.....	316	48.69
Number infected with Ascaris.....	229	35.28
Number infected with Trichuris.....	357	55.00
Single infections	267	41.14
Hookworm.....	99	15.25
Ascaris.....	45	6.93
Trichuris.....	123	18.95
Double infections	214	32.97
Hookworm and Trichuris.....	99	15.25
Hookworm and Ascaris.....	29	7.55
Ascaris and Trichuris.....	66	10.16
Triple infections	69	10.63

working with feces apt to harbor organisms of amoebic and bacillary dysentery and other pathogenic micro-organisms, and enabled us to delay examination of samples for several days whenever more pressing duties demanded our attention. The possibility of fraud and substitution in connection with samples of feces was taken into consideration, but in view of the interest that the students exhibited in this survey, the eagerness with which they awaited results of examinations, the numerous inquiries that they made concerning their individual cases and the requests for certification to the physician of the College of Agriculture for treatment, made it highly probable that each student submitted a sample of his own feces. It should also be stated in this connection that students at the Los Baños colleges live not only on the campus but also in adjoining settlements. Since students were required to submit samples of feces in alphabetical order, irrespective of classes

1. Only male students are in attendance at Los Baños. With few exceptions the ages range from twenty to thirty.

or other associations, the chances of practicing substitution were reduced to a minimum. It may be safely concluded, therefore, that each student submitted a sample of his own feces.

Each sample of feces was screened and the centrifuged sediment was usually examined in duplicate, and not infrequently in triplicate. Very few samples received but one examination. This procedure enabled us to detect very light infestations that would otherwise have been overlooked.

TABLE 2.—PREVIOUS RECORDS ON THE PREVALENCE OF INTESTINAL PARASITES IN THE PHILIPPINE ISLANDS

Number Examined	Locality	Percentage Infested	Percentage Infested with Hookworm	Percentage Infested with Ascaris	Percentage Infested with Whipworm	Authority
4,108*	Bilibid Prison	84.0	52.0	26.0	59.0	Garrison (1908)
385	Manila	89.0	13.45	53.22	87.60	Garrison and Llamas (1909)
1,000*	Taytay, Rizal	95.9	11.6	82.3	77.0	Garrison, Leynes and Llamas (1909)
1,087*	Bilibid Prison	70.0	16.7	37.5	40.0	Rissler and Gomez (1909)
6,108*	Las Piñas, Tuguegarao, Sta. Isabel, Ilagan, Isabela	89.83 74.13 86.28	11.14 8.01 46.38	77.21 73.55 60.59	53.4 25.9 6.23	Rissler and Gomez (1910)
119	Baguio	92.5	29.0	73.0	60.0	Chamberlain, Bloombergh and Kilbourne (1910)
183	Civil Hospital, Baguio	89.7	29.0	26.0	29.0	Same as above
932*	Cavite	85.6	2.4	67.2	65.1	Stitt (1911)
4,278	Cagayan Valley	85.46	54.37	62.04	7.99	Willets (1911)
150			33.0	32.0	44.6	Tenney (1913)
500*	Manila (necropsies)	Over 90.0	16.6	41.2	34.4	Crowell and Hammack (1913)
400	Batanes Islands	100.0	25.5	92.8	46.7	Willets (1913)
1,000	General Hospital, Manila	84.8	18.7	46.5	60.6	Willets (1914)
7,843	Bilibid Prison	69.1	22.2	40.9	47.1	Willets (1914)
1,063*	Cebu Hospital	66.5	31.31	27.82	41.11	Garcia (1917)

* Protozoan findings included.

RESULTS OF EXAMINATIONS

The results of examinations are given below in tabular form (Table 1).

A comparison of our total number of positive cases with those recorded by other investigators shows that with few exceptions that appear to be due to local conditions, our percentage of infestations with roundworms corresponds to the prevalence of intestinal parasitism in the

native population so far as available data are concerned.² The records obtained by other investigators in the Philippines are shown below (Table 2).

It will be seen from Table 2 that in examinations which involved large numbers of persons the percentage of infestation is close to 85 in most cases, and is in agreement with our results. The higher percentages shown in Table 2 are probably due either to peculiar local conditions, or to examination of certain classes of persons that are exposed by habits and by occupation to infestation with roundworms.

INFESTATION WITH HOOKWORM

As shown in Table 1, of the 316 students that were found to harbor hookworms, 99 (15.25 per cent. of the total number examined) were infested with hookworm alone, a similar number showed a double infestation of hookworm and whipworm, while 49 (7.55 per cent.) were infested with hookworm and *Ascaris*. The number infested with hookworm, *Ascaris* and whipworm was 69 (10.63 per cent.).

A comparison of our findings with those of other investigators (Table 2) shows that our percentage is higher than most averages hitherto recorded for the Philippine Islands. The averages obtained by Garrison (1908) and by Willets (1911) are somewhat higher than our own average. The discrepancy is even greater than the figures indicate when it is remembered that Garrison and Willets based the results of their examinations on direct smears and doubtless missed very light infestations. It must be concluded that inmates of Bilibid Prison examined by Garrison in 1908 showed a considerably higher hookworm index than the normal population of the Philippines. In this connection a comparison of Garrison's findings (Garrison 1908) with reference to inmates of Bilibid Prison with those of Willets (1914), whose findings are based on examinations of prisoners on admission to Bilibid, shows that during the time that Garrison made his examinations conditions in Bilibid were apparently favorable to the spread of hookworm infections, otherwise the discrepancy in the results of the two investigators is difficult to explain.³ The high percentage of hookworm infestation obtained by Willets (1911) appears to be due to the occupation of the persons examined, namely, field workers in tobacco plantations who go about their daily tasks barefooted. A similar explanation applies to the high percentage of hookworm infestations reported by Rissler and Gomez (1910) for Santa Isabel, Ilagan and Isabela.

2. Cestodes and trematodes are very rare in Filipinos and these parasites as well as protozoa are usually associated with nematodes.

3. Willets points out that improvement in conditions outside of the prison and the personal equation entering into the results do not account for the discrepancies.

Our own average would have been considerably lower if our examinations had not been based on concentrated fecal sediments and it is no exaggeration to state that about two thirds of our light infestations would have been overlooked in direct examinations of smears.

DEGREE OF HOOKWORM INFESTATION

Owing to the absence of hospital facilities on the university campus at Los Baños it was found almost impossible to secure specimens of hookworms passed following anthelmintic medication for the removal of worms, and no attempts were made to count the number of worms and to diagnose with accuracy the species of hookworms involved in this survey. The degree of infestation was judged by the scarcity or abundance of hookworm ova in fecal samples.

In a recent paper Smillie (1921) points out that while in individual cases the number of hookworm ova in stools frequently gives no trustworthy index to the number of parasites present, there exists nevertheless a definite relationship between the number of ova in stools and the number of hookworms harbored.

Only 47 positive hookworm samples showed an abundance of eggs that enabled us to make diagnosis readily. Of these only 9 samples contained eggs in great abundance, while 38 samples contained a moderate number of eggs, about one ovum in every four or five fields. The remaining 269 samples, approximately 85 per cent. of the hookworm positive samples, contained very few ova. In the latter samples from 1 to 3 eggs were generally found in each preparation and in many cases two or more slides were examined before a single egg was found. These data appear to indicate that while approximately 50 per cent. of those examined harbored hookworms, the vast majority of those that were infested were apparently lightly parasitized, as far as could be judged by the scarcity of ova in fecal sediments.

These observations on the lightness of infestation of Filipinos with hookworm are in harmony with those of other investigators. Garrison (1908) found that while 52 per cent. of the inmates of Bilibid Prison were infected with hookworm, clinical manifestations of the disease were not in evidence. Garrison makes no statement as to the degree of infestation with hookworm, but inasmuch as the clinical manifestations of hookworm infection are generally an index to the number of parasites present, it is very probable that Garrison's cases were, on the whole, lightly infested.

Garrison, Leynes and Llamas (1909) report that in the course of their parasitological survey of one thousand inhabitants in the town of Taytay they found very few hookworm ova in cover glass preparations, and that the greatest number of worms that they recovered after

treatment was 14. Rissler and Gomez (1910) confirm the lightness of hookworm infestation in natives of the Philippine Islands. These investigators state that in most cases that came under their observations from 5 to 10 hookworms were expelled after anthelmintic treatment and that in many cases only 2 or 3 parasites were recovered after treatment.

Willets (1911) found in over 4,000 examinations 54.37 per cent. positive for hookworm, but the degree of infestation was extremely light. He states: "In my opinion not less than 95 per cent. of the hookworm infections seen were distinctly mild in degree." Gomez (1911), in a study of 26 selected cases of hookworm infections, recovered from 1 to 20 specimens following anthelmintic treatment, having previously found few eggs in fecal samples. Walker, Guzman and Concepcion (1914) examined 58 persons in connection with a sanitary survey at Mindoro and found that 48.27 per cent. were infected with hookworms. Musgrave (1914) in collaboration with several physicians studied these cases clinically and found that most of these infections were light in character and that the clinical inefficiency of these patients was but little, if at all, lower than the general average. Haughwout and Horrilleno (1920) admit that hookworm infestations in the Philippines are frequently very light and without clinical manifestations, but they state that a number of cases of severe hookworm anemia have come to their attention.

SPECIES OF HOOKWORM IN THE PHILIPPINES

Numerous measurements of hookworm ova were made with a view of determining the species involved. By far the vast majority of eggs measured ranged from 68 microns to 75 microns in length, and were probably those of *Necator americanus*, while smaller eggs, 55 microns to 60 microns in length, probably those of *Ancylostoma duodenale*, were not uncommon. Since no accurate determination of hookworm species can be based on egg measurements, because the size of eggs of the two species of hookworms commonly parasitic in man doubtlessly overlap, no definite conclusions as to the relative abundance of *Ancylostoma* and *Necator* in the Philippines can be drawn from our data.

SIGNIFICANCE OF HOOKWORM INFECTIONS IN THE PHILIPPINES

Most investigators who have studied medical zoological problems in the Philippines are of the opinion, based upon considerable laboratory investigations and clinical findings, that hookworm infestation produces apparently no ill effects on Filipinos. The statements of Garrison (1908) concerning the absence of clinical symptoms in Filipinos harboring hookworms are confirmed by other investigators, notably by Willets, Gomez and Garcia. So far as the medical records of our

cases are concerned, including those with moderate to heavy infestations, there appears nothing to indicate effects of hookworm disease in the strict sense.

Garrison, Leynes and Llamas (1909) examined the hemoglobin content of hookworm positive cases but failed to correlate a low hemoglobin content with hookworm infection, even in cases of heavy infestations. Gomez (1911) compared the percentage of hemoglobin and the number of red and white blood corpuscles of 26 Filipinos infected with hookworm with those of 10 non-infected Filipinos and failed to find any noteworthy differences between the two groups. He concluded that the absence of clinical symptoms in Filipinos harboring hookworms is not due to racial immunity but to the small number of infecting organisms. Gomez has overlooked the fact that light infestations may, in themselves, indicate an immunity. Unless it can be shown that climatic conditions or conditions of the soil or other physical factors in the Philippines are inimical to the development of hookworm eggs and the survival of the larvae in the soil, the view that Filipinos have a racial immunity to hookworms is tenable. Gomez has also overlooked the fact that marked cases of hookworm anemia have been reported by certain investigators in cases in which few parasites were involved, whereas in Filipinos, so far as available information is concerned, even moderate and heavy infestations are often unaccompanied by anemia.

In view of the generally recognized importance of hookworm infection it is highly important that further investigations should be carried out before the lack of medical significance of hookworm infections in the Philippines is accepted as conclusive. Epidemiological investigations should be supplemented by experimental studies on the development of hookworm eggs and larvae in the soil, and on the duration of life of infective larvae in Philippine soils. Effects of tropical sunlight and of flooding rains on the ova and larvae of hookworms require thorough investigation.

INFESTATION WITH WHIPWORM

As shown in Table 1 of the 357 (55 per cent.) positive whipworm samples, 123 (18.95 per cent.) were infested with *Trichuris* alone. Double infections of *Trichuris* and hookworm numbered 99 (15.25 per cent.), double infections of *Trichuris* and *Ascaris* numbered 66 (10.16 per cent.), while triple infections of *Trichuris*, *Ascaris* and hookworm numbered 69 (10.63 per cent.). Of the 386 cases of whipworm infestation only 55 ranged from moderate to heavy and in these only four samples showed an abundance of eggs in feces. In the remaining 302 cases eggs were very scarce in fecal sediments.

Record obtained by other investigators on the prevalence of whipworm infestations in the Philippine Islands show considerable variation,

depending to a certain extent on geographical locations. Our average is in agreement with the general averages obtained in examinations of prisoners at Bilibid, but the fact that all investigations that are summarized in Table 2 are based on direct smears, whereas our records are based on concentrated sediments, must be taken into consideration. That *Trichuris* infestations may be accompanied by a severe progressive anemia has been recognized ever since Askanazy (1896) reported the presence of hemoglobin products in this parasite. The blood-sucking habits of *Trichuris* have been fully emphasized by Guiart (1907) and by others, and heavy infestations with these organisms are generally coming to be recognized as of considerable medical importance.

INFESTATION WITH ASCARIS

About one out of three students examined was infested with *Ascaris*, the total number infested being 229 (35.28 per cent.). As shown in Table 1 pure *Ascaris* infestations numbered 45 (6.93 per cent.), double infestations of *Ascaris* and hookworm numbered 49 (7.55 per cent.), double infestations of *Ascaris* and whipworm numbered 66 (10.16 per cent.), while triple infestations involving *Ascaris* numbered 69 (10.63 per cent.).

The majority of *Ascaris* positive samples, namely, 139 showed an abundance of eggs, whereas 90 samples showed comparatively few eggs. Among the latter many showed a pure culture of so-called abnormal *Ascaris* eggs that are commonly considered to be unfertilized eggs and are probably indicative of infestation with one or more female worms without the presence of male worms.

So far as concerns *Ascaris* infestation, our average is considerably lower than that recorded by most investigators, but is in general agreement with the averages found in Bilibid. As in our own cases, the inmates of Bilibid are nearly all adults. It has been repeatedly shown in helminthological surveys that children are more heavily infested with *Ascaris* than adults, the degree of infestation decreasing within certain limits with advancing age. Our average represents, therefore, the average for adult Filipinos.

The pathogenic rôle of *Ascaris* has been so well established by recent investigations on the migrations of the larvae through various organs, including the lungs, that no further emphasis is necessary to incriminate *Ascaris* as a probable important factor in respiratory diseases of children. Whether an invasion of the lungs by *Ascaris* larvae breaks down the vitality of these organs and increases their susceptibility to infection with tubercle bacilli and other pathogenic organisms is a question that still awaits solution.

SUMMARY AND CONCLUSIONS

The majority of normal adult Filipinos (approximately 85 per cent.) are infested with one or more intestinal roundworms.

Approximately 50 per cent. are infested with hookworm, but the vast majority so lightly parasitized, as judged by the scarcity of ova in feces, that direct smears may fail to reveal evidence of infestation.

Both species of hookworm commonly parasitic in man apparently occur in the native population of the Philippines.

Filipinos appear to be resistant to hookworm infection and do not appear to show, as a general rule, clinical symptoms of hookworm disease.

Whether a racial immunity is involved in this resistance or whether purely physical and other conditions unfavorable to the life of hookworm eggs and larvae in the soil are responsible for the light infections still remains to be determined.

Ascaris and whipworm are commonly associated with hookworm, the degree and incidence of *Trichuris* infection corresponding to those of hookworm infection. While *Ascaris* appears to be less common in adults than the above mentioned species it is generally present in greater numbers than the other species of intestinal nematodes mentioned in this paper.

The prevailing notions concerning the lightness of hookworm infestation and the absence of clinical symptoms in Filipinos harboring these parasites, though supported by considerable amount of data, should be confirmed by further investigations before the lack of medical importance that is now attributed to hookworm infections in the native population is accepted as an established fact.

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